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SPECIAL REPORT FOR SC B2 OVERHEAD LINES

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Special Reporters

Chair: Pierre VAN DYKE (CA) and Secretary: Vivek T. CHARI (IN)

INTRODUCTION

Study Committee (SC) B2 is responsible for the design, construction, operation, and maintenance of overhead lines. This includes the mechanical and electrical design and experimental validation of new line components (e.g., conductors, ground wires, insulators, accessories, structures, and their foundations), the study of line performance in service, assessment of aged line components, line maintenance including robotics, refurbishment and life extension as well as upgrading and uprating of existing overhead lines.

To encourage the sharing and promotion of new knowledge, SC B2 has selected the following three preferential subjects for the 2024 Session:

- PS1 - Challenges from renewables integration and influences of energy transition on OHL
- PS2 - Asset management, strategies, technologies and methods for OHL
- PS3 - Impacts from climate change on OHL

A total of 96 papers have been accepted and published including four NGN papers. The NGN papers, marked with an asterisk in the special report are **B2-11898**, **B2-11899**, **B2-11906** and **B2-11908.**

PARTICIPATION IN SC B2 GROUP DISCUSSION MEETING 2024

You are invited to participate in discussing this Special Report at the SC B2 session held on Friday August 30 starting at 08:45 in the Grand Amphitheatre at the Palais des Congrès de Paris.

In this document, the Special Reporters have compiled 36 questions synthesised from common issues and trends identified in the accepted papers. This provides the opportunity for a broader response and participation in the discussion session. We encourage you to share your views or experiences in response to the specific questions in this report.

More details on how to proceed are available at the end of this report.

Type here the email address of the Special Reporters as a footnote.

1. PS1 Challenges from renewables integration and influences of energy transition on OHL

Special reporter for PS1: Jean-François Goffinet (BE)

With the ongoing energy transition in different parts of the world, there is need for more capacity on existing lines. In some cases, building new lines is mandatory to cope with the extra demand and flexibility requested by renewables integration.

Most of the time, TSO's need Innovative solutions to mitigate increasing stakeholder opposition against new OHL (primarily based on noise and EMF) resulting in a "NIMBY" (Not In My Back Yard) attitude.

It is in this context that three subtopics were chosen for PS1:

1. Technical solutions for increasing power transfer capabilities of existing OHL's, methods for enhancing line/corridor utilisation: 11 papers address this subject (11422, 10574, 10977, 10957, 11899, 10790, 10954, 11717, 10900, 10912, 10173);
2. Methods and strategies to accelerate approval and permit processes, stakeholder engagement: Only 8 papers address this subject (10928, 10522, 11141, 11132, 11192,11177, 11759, 11044);
3. Innovative solutions and construction techniques for OHL's: 16 papers address this subject (10313, 10359, 10360, 10766,11199, 11527, 11667, 10620, 11523, 11687, 11550, 11724, 11506, 11510, 11472, 11776).

Contributions PS1 Group 1: Uprating related

A lot of papers deal with **Dynamic Line Rating** for optimizing utilisation of existing OHL's.

Paper **B2-11422** discusses the concept of thermal and ice loading time constants, which is appreciated.

Paper **B2-10790** describes a system for real-time continuous remote monitoring of the condition of overhead line conductors to minimize field visits by the line maintenance crew and provides early warning signals on potential abnormal and emergency situations**.**

Paper **B2-10954** examines the sensor deployment method for identifying which spans require sensors with an aim for implementing DLR in a safe and cost-effective manner**.**

> **Question 1.1:** What criteria are used to determine the number and the locations of the sensors? Could the authors or other experts provide more details?

Paper **B2-10977** introduces new innovative features on DLR, for example vibration measurements as well as machine learning for dynamic rating forecasting.

> **Question 1.2:** As the industry is beginning to evaluate the potential benefits of more distributed sensors on overhead lines, could the authors or other experts provide more insights on ongoing developments or the current need for sensors?

Paper *B2-11899 explores the complexities and uncertainties of DLR prediction. Metrics for evaluating the benefits and intrinsic risks are discussed.

Paper **B2-10900** demonstrates a well proven concept that DLR can achieve significant gains over the conservative static ratings. However, the cost/benefit (reduction of market constraints) challenges in applying DLR over the whole circuits for long transmission lines in terms of implementation costs (including outages costs to install the system) and operational costs of the sensors (large quantity and reliability) of the system still need to be addressed.

> **Question 1.3**: Could the authors or other experts comment on experience/learnings with cost/benefit analysis for long circuit deployment and/or sensor reliability/operational issues?

Paper **B2-10912** presents a framework of systematic approach of numerical forecasting for DLR estimation based on 11 months of data collected from sensors installed on a 110 kV line. Evaluation of different forecasting models considered are included.

Paper **B2-11717** presents a proposed DLR system based on a dynamic thermal circuit architecture using data from existing meteorological station and real time conductor current data.

> **Question 1.4**: Could the authors and other experts comment on whether the proposed DLR system can be relied on to forecast ratings for a line having multiple sections with different orientation and environment/terrain conditions when the existing meteorological stations are not in the proximity of the line?

Only two papers are fully dedicated to the use of **HTLS** conductors.

Paper **B2-10574** describes the challenges when replacing a conventional conductor with an **HTLS** conductor for uprating an existing 380 kV overhead line. Various aspects on EMF, financial and especially structural are discussed.

Paper **B2-10957** presents an analysis of the characteristics of HTLS conductors for their use in regions with high ice loads, which has been little studied to date.

Contributions PS1 Group 2: Acceptance related

Different papers address **noise-related** topics that are very important for reconductoring projects in densely populated areas, sometimes linked with more stringent noise regulations.

Paper **B2-11132** reports about the construction and testing of OHL conductors-fittings system with noise reducing properties.

> **Question 1.5**: Would the authors or experts from other utilities/countries share their experience in noise reducing solutions?

Paper **B2-11177** reports about new noise prediction models for new (hydrophilic) conductors in low-rate rain falls.

> **Question 1.6**: Would the authors or experts from other utilities/countries share their experience in modelling and facing noise issues in low-rate rain falls?

Different papers address **compact line design** topics which are quite important for acceptance of OHL's in densely populated areas.

Paper **B2-10522** deals with the application of Portable Earthing Devices in relation with the safe maintenance of compact Multi-Circuit Multi-Voltage OHL in the Netherlands.

Paper **B2-10928** describes the use of different technologies for insulators subjected to bending (solid core and hollow core), UHV applications and the use of insulated crossarms in tension or angle towers. This paper points out the necessity of having a design and testing standard for the full insulated crossarms.

> **Question 1.7**: Could the authors or other experts comment on this?

Paper **B2-11141** describes the mechanical and electrical challenges when existing line structures are used for a voltage uprating in UK. Limitations of insulated cross-arm to uprate tension towers are discussed**.**

> **Question 1.8**: This Retrofit solution may request further investigations on a demo installation (like safe work procedures and design optimisation) before implementation on a full line. Could the authors present any insights for the CIGRE community?

Paper **B2-11192** reports a "compact line design" for crossing an environmentally sensitive region in Colombia, in which HTLS (PMC type) conductors, steel poles and line post composite insulators were used. The use of helical anchor type foundations was also highlighted, as well as a reduction of up to 35% in the right of way obtained.

Paper **B2-11759** describes a 3D visualization tool to accelerate line routing and identify optimal alternatives.

Contributions PS1 Group 3: Innovation related

Different papers deal with **optimal design**.

Paper **B2-11199** deals with the optimal routing of an overhead line by considering a broader set of variables and alternatives than those currently used in commercial software.

Paper **B2-11667** discusses the historical use of different steel grades in lattice towers, highlighting the recent introduction of high-strength steel grade S460 in 2019, still with limited adoption due to the lack of design recommendations in normative documents.

> **Question 1.9**: Could the authors or other experts provide more insights or tips helping adoption of this new grade?

Different papers address **HVDC** topics which are quite important when you consider building new OHL on long distances to face increasing energy demand, transport of big amount of Renewable Energy sources or the need for more interconnections with neighbouring regions or countries. Another option is the conversion of a line from AC to DC.

Paper **B2-10313** aspires to motivate utilities and IEC to revisit the limited test results on DC insulator strings performed with clean fog testing.

> **Question 1.10**: Would the authors or experts from other countries share their views on this necessity and justify how it could improve the design and performance of HVDC OHL's?

Paper **B2-10359/360** provides interesting information about Terna's strategy for bulk power transmission, i.e., the application of backbone HVDC lines for +/-525 kV DC. The new 400 kV AC line, which can be converted to DC by replacing the top of the tower and re-arranging the conductors, is also of great interest.

> **Question 1.11**: Would the authors or experts from other countries share their experience on the conversion of an AC line to DC?

Paper **B2-10766** is a good document describing the use of Cross Rope Suspension towers for High Surge Impedance Loading lines.

> **Question 1.12**: Can the authors explain the choice of a 500 kV line voltage rather than 765kV, which may have been more compatible with the load transfer requirements?

Papers **B2-11506/11527** give an interesting presentation of the challenges associated with building an HVDC line in very harsh environments. Many types of problems are described along with possible solutions.

> **Question 1.13:** There are many issues not yet addressed in this paper, mostly related to operation of the line such as repairs of failed towers, selection of reliability level, extrapolating of knowledge to unchartered conditions, validation of icing and wind values, etc. Could the authors or other experts provide more details?

Paper **B2-11176** discusses the application of artificial neural networks (ANNs) for determining electric fields intensity near the ground surface under overhead power lines, and in the immediate vicinity of conductors. The goal is to demonstrate the application of artificial intelligence to determine the electric field generated by overhead lines. The results of the AI approach are compared to field measurements and calculations.

> **Question 1.14:** Can the authors elaborate on whether similar methods using ANNs can be extended to other design aspects relating to OHL design? Can experts from other utilities share methods in which AI technologies have been used in design phases of new OHLs?

2. PS2 Asset Management, Strategies, Technologies, and Methods for Overhead lines

Special reporter for PS2: Sharon Mushabe (ZA)

The increasing demand for renewable integration and decarbonisation of the power grid is putting pressure on utilities to ensure availability of their assets. This means that utilities must have good understanding of their condition and good estimation of residual life of these assets to realise these demands. This is especially key as there are several thousands of kilometres of overhead lines around the world that have been in service for many years.

Three subtopics were chosen for PS2:

- Safeguarding of existing OHL from impacts of external infrastructure, encroachments, vandalism, sabotage
- Asset health index (AHI), time-based and risk-based inspections, ageing, residual life assessments, protective treatment of components
- Innovative maintenance methods, use of artificial intelligence (AI), augmented and virtual reality techniques (AR-VR) and increasing resilience

There were 44 papers accepted for PS 2 which were divided into the following three subgroups:

1. Asset Management of OHL components, covering the following subtopics:
   - Conductors
   - Insulators
   - Tower and Foundation Designs
   - Determining an Asset Health index (AHI)
2. Inspection and monitoring techniques of OHL, which includes:
   - Use of UAVs
   - Use of Artificial Intelligence (AI) and Machine learning (ML) for inspections
   - Use of digital twins
   - Maintenance of Right of Way (RoW)
3. Electrical Performance and Safety, comprising
   - Grounding systems
   - Electrical and Worker Safety.

Contributions PS2 Group 1: Asset Management of OHL components

Conductors

Six papers covering non-destructive testing on conductors, causes of audible noise and the determination of residual life are covered in this section.

Paper **B2-10314:** The authors undertook to collect and organise NDT data in a database, with the aim of improving knowledge of the general condition of OHL conductors in operation, particularly ACSR conductors. An existing test bench was used to confirm the detection of conductor damage by external NDT service providers. The paper focuses on the Magnetic Flux Leakage sensor technology.

> **Question 2.1:** Could the authors of paper **B2-10314** or other experts share what are the relevant technological NDT candidates to assess other conductor types (e.g. AAAC, HTLS, etc) are?

*Paper **B2-11906** introduces the breakdown voltage analysis technique, widely used in case of cables, as a possible diagnostic method of composite core of conductors.

*Paper **B2-11908** deals with corona induced audible noise emitted from water droplets on OHL conductors. The investigations were carried out on single water droplets in an anechoic chamber.

Paper **10736** investigates the causes of the audible noise generated by overhead conductors under rainy conditions, combining the effects of the different conductor sizes and surface treatments.

*Paper **B2-11898** describes a framework that was developed to assess and estimate the residual life of overhead conductors under the influence of aeolian vibrations. The proposed framework covers wind estimation data, the development of an aeolian vibration model and total fatigue loading using experimental data from a test line in Canada.

Paper **B2-10137** The authors describe a numerical tool that they have developed that serves as a virtual test bench for an overhead line span. The tool can be used to assess the dynamic response of a span due to wind induced vibration as well as determine its estimated end of life.

> **Question 2.2:** Can the authors of paper **B2-10137** share if this tool can be used to determine the asset health index of a conductor? Experts from other utilities, may share tools/methods that they have used to determine the asset health index of a conductor.

Insulators

There were 7 papers that covered condition assessment of insulator coatings and composite insulators. One paper, **B2-11160**, investigated a curious cause of audible noise on a de-energised line**.**

Paper **B2-10490** describes a comprehensive test program undertaken for condition assessment and health indexing of porcelain and composite insulators of in-service OHL of Transgrid (Australian TSO). Details of various tests carried out on porcelain insulators of 132/330 kV OHL (27-72 years in service) and composite insulators of 330/500 kV OHL (1-21 years in service) have been presented.

> **Question 2.3:** May experts share how maintenance strategies have been adopted for the condition assessments of porcelain and composite insulators? For the authors of paper **B2-10490**, how were the test results adopted for risk-based maintenance of the insulators?

Paper **B2-10501** covers evaluation of different condition assessment and inspection techniques for finding defects in polymeric insulators. Based on inspection/tests (visual inspection, thermography, corona/UV inspection, etc.) conducted in laboratory on a set of composite insulators removed from a 220 kV OHL of REN (Portuguese TSO), it has been suggested that visual inspection by drone would be the most effective technique of finding defects in composite insulators.

Paper **B2-10735** demonstrates that even with a nitric acid surface layer, the hydrophobicity of the silicone materials tested, showed recovery and transfer capabilities. Nitric acid does not appear to negatively impact the performance of silicone insulators.

Paper **B2-10981** compares, based on field experience, the performance of RTV coated insulators vs non-coated insulators, especially regarding the audible noise and visible light from partial discharges on insulators. A repair guideline for RTV coating damage is provided.

Paper **B2-11471** analyses the effectiveness of insulator coatings by analysing glass and porcelain coated insulators that were removed from a 400 kV network in Saudi Arabia after 15 years in service.

Paper **B2-10986** discusses the failure mechanism for a composite insulator interphase spacer that had been in used for 25 years in a heavily polluted area. The authors propose that the failure is a result of the surface deterioration on the insulator rubber resulting from atmospheric pollution and progressing inward to create the damage.

> **Question 2.4:** Many papers/literature are available describing effectiveness of inspection techniques other than visual inspection (viz. thermo-vision scanning, corona/UV inspection etc.) for condition monitoring of composite insulators. May experts/utilities share their experiences in using different techniques of inspection of composite insulators?

Paper **B2-11160** describes investigation and wind tunnel testing carried out to determine cause of high noise emissions during stormy wind conditions (65-80 km/hr wind speeds) in some stretches of 380 kV OHL of Austria Power Grid on a de-energized line. Based on the results of wind tunnel tests on glass insulator strings with different insulator types/profiles, standard profile glass insulators used

in the affected stretches of OHL have been replaced with fog type insulators in 2023. Effectiveness of the replacements is planned to be verified in 2024.

> **Question 2.5:** May the authors of the paper **B2-11160** elaborate on the effectiveness of the insulator replacements, did the replacement resolve the issue of the high acoustic emissions? Will this specific type of insulator profile be used for new overhead lines built in similar areas? Can other utilities that have had a similar experience with high noise emissions as those described in the paper share their experience?

Tower and Foundation Designs

The four papers in this section discuss methods for detecting and monitoring on operational performance of OHL due to rain/ice/snow weather events.

Paper B2-10973 discusses the development of design methodology for deployment of a slim tower built within the frame of an existing 275 kV tower. The system has already been successfully implemented for 66 kV lines.

> **Question 2.6**: Can authors of paper **B2-10973** or other experts that have developed a similar tower, answer the following questions:
>
> a) What was the project driver for the development of this tower, was it to accommodate an uprating exercise needing larger conductor or bundles?
> b) Was the intent of the new structure to replace the existing structure or would it work in unison with the existing structure to support the new duty?
> c) How does the cost compare with other uprating solutions – e.g. HTLS conductor?
> d) Can the authors elaborate on the footing/foundation solutions that might be possible per the reference in the paper to previous experiments?

Paper B2-10979 presents an innovative solution for repair/reinforcing existing tower members using carbon fibre components. The paper includes both FEM (finite element modelling) and material testing to validate the methodology.

> **Question 2.7:** Can authors of Paper **B2-10979** comment on the allowable limits for loss of section due to corrosion that would trigger such repair solutions?

Paper B2-11508 provides a case study of challenges encountered for repair of defects on submerged cast in-situ concrete foundations.

Paper B2-11672 describes a gantry system directly connected to damaged 380 kV tower/structure to temporarily stabilise the structure until permanent repairs can be implemented.

Determining an Asset Health Index (AHI)

These three papers cover the broader subject of determining the asset health index of a transmission line.

Paper **B2-11524** presents the methodology used by a TSO in India to calculate residual life for their transmission line assets based upon an asset health index. Health index considers factors such as vulnerability, structural defects, failure history, aging, and environmental conditions.

Paper **B2-11630** describes the use of asset health index as an input for risk-based asset management for overhead lines. It includes using the FMECA process to evaluate the effectiveness and impact of routine actions. Using this approach can minimise risks and allow for optimal allocation of resources.

> **Question 2.8:** Could the authors (and other experts) share their practical experiences in the implementation of AHI for a risk-based asset approach on overhead lines? Kindly elaborate on the strategic value towards the transmission grid in your company.

Paper **B2-11007** shares how a DLR-H systems can assist in understanding asset condition without the need to carry out physical inspections. The paper shares a health monitoring system that allows one to monitor changes in the mechanical and vibration behaviour of a tower. The work presented indicates that once more data is collected more complex health indices could be developed.

Question 2.9: Could the authors of paper **B2-11007** or other experts that have used DLR-H systems comment on whether such a system could be extended to identify active vandalism and/or sabotage of assets? If so, please elaborate how this could be achieved?

Contributions PS 2 Group 2: Inspection and monitoring techniques of OHL

Technological advances in inspections and monitoring tools have made a significant impact on day-to-day life as so to in the asset management of overhead lines. The developments in artificial intelligence (AI), machine learning (ML) tools and models are allowing engineers to make better decisions in a data driven world.

Sixteen papers were selected covering the topics on the use of UAVs in utilities, the use of AI/ML, and the development and use of digital twins for OHLs as well as maintenance of the Right of Way using satellite imagery.

Use of UAVs

Paper **B2-11194** describes how existing drone standard maintenance routines (SMR) used in Colombia were refined by considering pre-operational activities and the inspection sequence of the drone inspection. A comparison of the transmission line inspection by the drone vs conventional manual visual inspection is made.

Paper **B2-11230** describes the Peruvian experience using drones for transmission line inspections. They compare the costs of the drone inspections to conventional manual visual inspections across the different landscapes found in Peru, namely: along the coast, across the Andean mountains and the forests.

Question 2.10: Can utilities that have introduced drone inspection technology in their TSOs share their experience (vs conventional human methods) on: cost of inspection, time to conduct inspection, image processing (developing and training), database management, accuracies, custom made algorithm? Do they use in house facilities and resources or is the function contracted out to independent service providers?

Use of Artificial Intelligence (AI) and Machine learning (ML) for inspections

Paper **B2-11504** introduces an AI/ML methodology to estimate the vulnerability index of transmission lines using techniques like clustering, decision trees, and various data sources, helping prioritize maintenance and patrolling. It also proposes a convolutional neural network (CNN) -based approach for automatic defect identification from tower images, reducing manual effort and improving objectivity in the inspection process.

The current trend in industry is to incorporate both unmanned aircraft (drones) to capture asset data, use of cloud storage and computing to manage and analyse large data sets, and utilising machine learning to develop algorithms to identify defects and/or grade asset condition. Paper **11710** outlines HEDNO's development of a system that combines these technologies to assist in managing risk in a trial area of their medium voltage line asset base.

Paper **B2-10980** describes an automated drone inspection system that was developed to inspect towers and in span conductors without affecting the quality of the data captured. Tower co-ordinates and dimensions are used to generate a flight route and define a no-fly zone around the tower. The system also performs real-time defect identification on conductors and insulator using machine learning techniques.

Paper **B2-10336** highlights the gaps that still exist between training models and practical implementation in AI performance during transmission line inspection and monitoring. It presents a pipeline for continuous AI improvement.

Paper **B2-10778** describes how AI techniques were applied to analyse and identify corrosion rates from images of samples taken of carbon steel and galvanized carbon steel from the field and laboratory specimens in Brazil.

Paper **B2-10921** presents an inspection approach to detect the severity of corrosion on transmission tower members using hyperspectral imaging. Images are taken using a hyperspectral camera mounted on a drone and the image processing pipeline used is described in the paper.

Use of digital twins

Paper **B2-11353** details the development and use of temperature monitors on conductors that can be used for dynamic line rating and asset management. It makes use of sensors that can be installed on a multitude of spans, for a given period of time, so that the line ampacity inputs/output can be fed through a neural network for AI learning, and after a year of training, an artificial neural network based digital twin connected to the sensor can be operated by itself, while the actual hardware sensors can be moved to another stretch of the grid. The digital twin development reduces number of sensors required and thus the costs incurred for the exercise.

Paper **B2-11314** provides an overview of the risk management aspect of overhead lines which can be facilitated by the implementation of digital tools and processes like a digital twin that only considers the mechanical design. A storm scenario is simulated on the digital twin model. The simulation suggested that 3% of poles would fail on the 11 kV network if exposed to sustained gusts of 160 km/h.

> **Question 2.11:** Is there any experience from other utilities that have digital twins of their networks that are capable to predict failures on their transmission lines due to storm conditions or other weather events or indicators? Have the results been used by the utilities to make changes to their network and were changes effective or tested? Give examples and/or share your experience.

> **Question 2.12:** Can the authors of paper **B2-11353** give an indication on the cost of one unit as well as cost involved to install and monitor for a year to develop a digital twin of the network?

Maintenance of Right of Way (RoW)

The papers in this section cover methods to detect activity in the RoW, such us fires, vegetation management with the use of AI and satellite technology.

Paper **B2-10175** sets out an advanced image processing technique for classification of forest fires. It uses a modified YOLOv8 network model and transfer learning. Its performance is shown to be an improvement on existing techniques.

Paper **B2-10500** presents new technological advancements used to detect the location of fire and simulate fire spread up to 5 hours using sensory systems that enable real time tracking for protecting OHL assets in Portugal. The detail presented is comprehensive to address bushfire issues and methods to analyse issues in such extreme scenarios.

Paper **B2-11108** summaries the work done by TSO in Australia to understand and verify the condition and operability of transmission line conductor that were affected by bush fires in 2019/2020. The approach used included aerial photography and custom trained deep learning model to analyse the millions of images generated, LiDAR inspection and laboratory testing.

Paper **B2-11515** The paper presents an algorithm and AI-based approach that utilizes geospatial data to optimize the routing of power transmission lines by finding the shortest path while avoiding obstacles like forests, habitats, line crossings and existing infrastructure.

Paper **B2-10768** highlights new advances in nanosatellite imaging and its application to assist the monitoring of intrusions into the right of way. The TSO in Brazil demonstrates how they have applied the technology in a cost-effective manner to manage an increasingly big issue on their ROWs.

Paper **B2-10705** evaluates the use of satellite imagery for vegetation management and monitoring land-use changes near overhead lines (OHLs) by Elia Group. It explores the integration of satellite data and analysis into OHL inspection and maintenance processes.

> **Question 2.13:** Have other utilities had experiences that they can share of satellite or nanosatellites technology to monitor activity in RoW? Has this technology been used to detect

other activities such, fires, vandalism, encroachments? Please elaborate on effectiveness of this use.

Contributions PS 2 Group 3: Electrical Performance and Safety

There were eight papers that covered grounding systems and lightning performance as well as electrical and worker safety.

Grounding systems

Inadequately designed grounding systems can result in the poor performance and the failure of power system equipment and overhead line components. The following papers address improvements and analysis of grounding systems on overhead lines.

Paper **B2-10176** presents the outcome of analysis done on the number of shielding failures and back flashovers detected using distributed line travelling wave system, located on several locations along a 140 km 500 kV transmission line.

Paper **B2-10178** presents the performance outcome of various earthing/grounding designs involving vertical rods and horizontally laid electrodes. The authors compare impulse test results in high and low resistivity soil for the same four practical electrode configurations.

Paper **B2-10179** explores the shielding failure and back flashover rate on several transmission lines running in parallel in shared ROW. It deals with a refinement of the electro-geometric method. It investigates the correlation of the horizontal distance away from (from centre-to-centre ROW) and the difference in heights against the tower/location of earth wires of the adjacent parallel lines with the effectiveness of shielding.

Paper **B2-10618** This paper acknowledges that corrosion is a major issue for high voltage overhead transmission lines. It can affect tower structure, overhead ground wire (OGW), down-conductor and the grounding electrode. The use of insulating fibre-reinforced polymer (FRP) high voltage towers is becoming a technical option to replace the use of conventional metallic or concrete towers in locations next to sea or polluted environments. This paper analyses the possibility to remove partially grounding system at some FRP towers due to the isolating features of this type of towers, leading to economic saving, and drastically reducing the problems related to contact and step voltages.

> **Question 2.14:** Would the authors or experts from other utilities/countries share their experience with the use of grounding systems on FRP towers?

Electrical and worker safety

Safety is assigned the highest priority by most utilities and construction/maintenance delivery partners. The following papers describe methods for ensuring a safe work system has been implemented to keep workers and the public safe and free from injury.

Paper **B2-10502** acknowledges that electromagnetic interference of overhead lines or underground cables on gas pipelines can undermine personnel safety and can damage the gas pipeline or accelerate its corrosion. The authors present a technical specification for evaluating the interference caused by the operation of overhead lines or underground cables crossing or in the proximity of its gas pipelines and the acceptable interference levels. They apply a three-dimensional finite element method capable of describing the electromagnetic interference.

Paper **B2-11082** The paper presents a case study for the use of a rail safety device known as a 'voltage limiting device' consisting of a line surge arrester paralleled with back-to-back thyristors. This is used on the earth wire of a 33 kV system with an 11 kV underbuilt circuit to enable steel pole construction for a rail network distribution line.

Working at heights is recognised as a critical hazard by many utilities and contractors. Paper **B2-10621** discusses technological advances in sensory systems that may be used to control this hazard.

Question 2.15: Can the authors of paper **B2-10621** elaborate on the fitment of the sensory device? How does the device detect that proper anchoring has been achieved when using a double lanyard system? Have the authors noted any reluctance from line workers to fit these devices in relation to concerns about monitoring of their individual work habits or other reason?

Paper B2-11357 analyses accident data collated from the United States industry of OHL workers exposed to electrical hazards. The paper identifies the most common accidents do not occur in the case of trained live line operators making direct contact with conductor energised at operating line voltages. Instead, the root cause is more often associated with work on "de-energised" lines due to incorrect switching or earthing procedures. The paper provides recommendations for improving safety based upon its findings.

Question 2.16: a) The authors of **B2-11357** identified four broad categories for the root cause of accidents including lack of PPE, inadequate attention/knowledge and failure of equipment. For clarity, can the authors elaborate on:

- Proportion of accidents in each category related to live work (i.e. conductor energised at line voltage) vs de-energised work.
- Numbers of incidents due to inadvertent movement of plant.

b) Can the authors offer specific recommendations for managing safety in relation to operation of mobile plant near energised parts?

3. PS3 Impacts from Climate Change on Overhead Lines
Special reporter for PS3: John McCormack (AU)

Climate Change is dramatically transforming weather patterns with effect on every sphere of human endeavour. The worldwide overhead line electricity network is particularly vulnerable because of the widespread distribution across geographic region around the world and its exposure to every conceivable meteorological condition. It is imperative the industry identify those impacts that can compromise operational performance of OHL arising from unseasonal climatic behaviour; and even more critically, compromise security of OHL assets by ever increasing storm intensity. Only then can the industry be able to optimise cost-effective solutions to mitigate such effects and thereby maintain integrity of the network.

The intent of PS3 is to investigate climate change impacts on OHL; and evaluate current practices adopted or proposed by the industry to reduce effects on operational performance or minimise risks of loss of service altogether.

Two subtopics were chosen for PS3:

- Impact on OHL design and operations due to climate change
- Lessons learned for TSO/DSO, studies and practical experiences from a changing environment

The papers are divided into the following four broad subgroups:

1. Prediction and monitoring impacts on OHL arising from weather events.
2. Mechanical loading.
3. OHL operational performance.
4. Fire mitigation strategies.

Contributions PS 3 Group 1: Prediction and monitoring impacts on OHL arising from weather events

The following papers discuss methods for detecting and monitoring impacts of extreme weather events on operational performance of OHL.

Paper B2-10183 investigates a novel approach (electromagnetic dampers) to suppress conductor movement subject to ice shedding that would otherwise compromise electrical clearances.

Paper B2-10185 outlines a probabilistic model for a galloping distribution map that might be adopted for other regions subject to this phenomenon.

Paper B2-10982 investigates the detection of salt-laden snow accumulating on insulators that can lead to line outages and suggests possible mitigation solutions.

Paper B2-11155 describes a validation of field monitoring trial to measure accumulation of ice that can then be used to plan mitigation actions.

Paper B2-11196 describes a monitoring system to detect landslides due to increasing intensity in rain events as part of managing risk of damage to OHL structures.

> **Question 3.1:** Are utilities detecting measurable changes in operational performance due to impacts arising from extreme weather events? If so, what types of events and impacts are most common?

> **Question 3.2:** Is the prediction of lower frequency but longer duration icing events described by authors paper **B2-11155** consistent in other regions. Can experts comment on the effectiveness of prediction/monitoring tools currently in use for managing icing events?

Contributions PS 3 Group 2: Mechanical Loading

Extreme weather events are increasing in frequency and intensity due to climate change. This places at risk the security of much of the existing OHL network designed to older standards founded on synoptic wind models and return periods generated from historical wind records. Many design standards already recognise the differences between synoptic and thunderstorm wind characteristics but have yet to impose higher wind speeds that could be result of changing conditions that cannot be predicted by existing wind models.

Three papers (**B2-10307, B2-11507 & B2-11635**) address issues relating to increased mechanical loads on structures arising from wind events.

Paper B2-10884 presents a model of mechanical loads caused by icing and wind weather conditions and compares results to transmission line tower design parameters in time series. According to the authors, this approach yields estimate of frequency of occurrence of maximum loads which can be further used for asset management and design adjustments.

Paper **B2-10983** discusses an alternative tower framing system to mitigate effects of increased gravity loads due to snow accretion.

Paper **B2-11083** describes a GIS based analysis of ice loading that gives rise to failure risk for transmission lines.

> **Question 3.3:** Can utilities comment on changes under consideration, or have been implemented, of design loading criteria exceeding current national or international standards to manage increased loads due to extreme weather events? If so, what is the basis for these changes and/or evidence used to justify such decisions?

Contributions PS 3 Group 4: OHL Operational Performance

Four papers address issues relating to electrical performance of overhead lines.

Papers **B2-10184 and B2-11223** address line performance in relation to overvoltage events including that caused by lightning storm activity.

Papers **B2-10608 and B2-11158** discuss line ampacity issues relating to solar radiation impacts and low wind speeds respectively.

> **Question 3.4:** Climate change has been attributed as a cause to changes in the world's weather patterns including increased atmospheric discharge (lighting) characteristics that, in turn, give

rise to increased overvoltage events and line outages. Are utilities actively modifying design rules for the development of new assets to counter such affects based on measurable changes in performance of existing lines?

Question 3.5: Maximising dynamic line rating is dependent on reliable measurement and prediction of light wind speeds, and to a lesser degree solar radiation absorption and emissivity characteristics of conductor. Can experts comment on changes in the factors impacting on DLR attributed to climate change and effects on reliability of predictions of line rating?

Fire Mitigation Strategies

CIGRE has published a Technical Brochure TB 767 investigating the impacts of vegetation fire encroaching on OHL. Paper **B2-10186** provides an alternative model for evaluating risk of line outages caused by vegetation fires.

Paper **B2-10327** evaluates performance of covered conductor to reduce risk of fire start from overhead distribution lines. This work will be a valuable contribution to the current CIGRE SC B2.72 working group that is preparing their publication about causes and mitigation of fire starts from OHL.

Question 3.6: Fire start from an in-service OHL is always rated as a major or catastrophic risk due to the potential cost of damage to the public and third-party property, not to mention the public image of the utility. Can experts comment on methodology used to establish likelihood of a fire start, as well as evaluate extent of the fire to establish consequential costs in order to undertake an appropriate risk assessment?

General information about Contributions and SC B2 activities during the 2024 Paris Session

B2 Group Discussion Meeting and Preview Meeting

The B2 Group Discussion Meeting (GDM) will be held on **Friday 30th August**, at the "Grand Amphitheatre" from 08:45 to 18:00.

Contributions and Preview Meeting

All contributors shall follow the following procedure:

1. Each duly registered delegate and author of a session paper wishing to present a contribution to the questions raised by the Special Reporters in this Special Report has an opportunity to post a contribution on through the registration portal, link : https://registrations.cigre.org/. The portal will be open for uploads from end of May until 10th August 2024. **No new contributions will be accepted after August 10th, 2024**. Contributions can only be made by contributors that will be present in Paris.
2. Contributors must prepare **two** versions of their contributions: a **visual** version for the GDM – 2 or 3 slides maximum (including text and visuals such as graphs or photos) and a **written** version (text only). It is important that each contribution is easily identifiable. Each file must be named as follows: **SC_PS*_Question Number_CONTRIBUTOR'S NAME (in capital letters)_Country (official short name),** for example B2_PS3_Q3.5_WANG_CN. The contributions shall be prepared in the dedicated template. A guide for contributors, as well as templates and sample pages will be available on the CIGRE > CIGRE Session 2024 website.
3. A confirmation email will be automatically sent to the delegate once the contribution has been posted. Kindly note that only registered delegates can access the contributions section.
4. Contributions will be made available to Study Committee Chair and Special Reporters for review and comments.
5. Contributors will be informed about the outcome of the review through the registration portal as soon as the review is completed but **no later than August 15th, 2024**. All contributors with

accepted contributions will receive instructions on how to finalise the presentation should adjustments and revision be needed.

6. All contributors with accepted and finalised contributions shall meet the SC Chairman, Secretary and Special Reporters as part of the preparatory work for the Group Discussion Meeting. The preparatory meeting is aimed to be held virtually during August and prior to the conference in Paris. During the meeting the contributors will receive instructions regarding the session and can ask questions. Contributors unable to attend the virtual meeting on **Friday August 16th 12:00 (Paris time)**, prior to the preparatory meeting, inform the Special Reporters and ask for a dedicated time slot to meet the SC Chairman, Secretary and Special Reporters in person on Thursday August 29, the day before the Group Discussion Meeting. (Room: TBA; Preliminary time: 14:00-15:00 & 17:00-18:00).

   Important note:
   - All contributions will be uploaded prior to the Conference in Paris.
   - Last minute changes to the contributions will not be granted.

7. It is expected that the questions relevant to the three Preferential Subjects will attract many prepared contributions. The number of contributions for each Preferential Subject may need to be limited. The selection will be based on relevance, quality and time of submission of the contribution.
   Opportunity will be given for spontaneous verbal (no slides) contributions during the session. Attendees who provide a spontaneous contribution, are encouraged to summarise their contribution as a short, written response for the Proceedings. To be considered in the proceedings the summary is required to be submitted within two weeks after the SC B2 Session by **Friday September 13, 2024**. The written summaries shall be sent to SC B2 Secretary (Vivek T. Chari, vivek@tagcorporation.net).

Poster Session

It is expected that authors of B2 Session Papers present their papers at the B2 Poster Session which is on **Thursday 29th August from 08:30 to 12:30**. To accommodate all the paper submissions, the poster session will be divided into two groups; Group 1 will present from 08:30 to 10:25 and Group 2 will present from 10:35 to 12:30. The details of the group allocations will be communicated to the authors/presenters at a later date. The presentation will be on video screens (no paper print out necessary). Authors shall send their posters to the B2 Poster Conveners (Ana Lovrencic and Kerstin Weindl) who will review the draft posters.

After confirmation they will upload the files in advance for the Palais des Congrès. Authors will not have the possibility to upload their own files. If the author(s) cannot attend the Poster Session he/she or the relevant National Committee is requested to send a substitute.

Details will be issued soon on the CIGRE homepage.

B2 Tutorial and Workshop

Please note that the B2 **Workshop** on 'Corrosion assessment and repair of existing OHL supports, anchors and foundations' will be held on **Wednesday morning (28th August)** from 09:00 to 12:30 and the B2 **Tutorial** 'Risk Management of Overhead Line networks: A model for identification, evaluation and mitigation of operational risks (WG B2.77)' will be held on **Wednesday afternoon** from 16:10 to 18:00.

Contacts

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B2 Chair:	Pierre Van Dyke, vandyke.pierre@hydroquebec.com

B2 Secretary:	Vivek T. Chari, vivek@tagcorporation.net

The key dates of SC B2

Day	Date	Time (UTC+2)	Room	Description
Saturday	2024-08-10			Deadline for submission of the prepared contributions on the registrations portal
Thursday	2024-08-15			Deadline for informing the contributors about the outcome of the review
Friday	2024-08-16	12:00	Teams meeting	Virtual contributors' meeting with SC Chairman, Secretary and Special Reporters
Wednesday	2024-08-28	14:00-16:00	TBA	Remaining contributors' meeting with SC Chairman, Secretary and Special Reporters
Thursday	2024-08-29	8:30-10:25	Hall Ternes, floor 1	**SC B2 Poster session – Group 1: PS1 and PS3 paper**s - Opportunity to meet authors and discuss papers
		10:35-12:30	Hall Ternes, floor 1	**SC B2 Poster session – Group 2: NGN and PS2 papers** - Opportunity to meet authors and discuss papers
Thursday	2024-08-29	14:00-17:00	TBA	Remaining contributors' meeting with SC Chairman, Secretary and Special Reporters
Friday	2024-08-30	8:45-18:00	Grand Amphitheatre	**SC B2 Group Discussion meeting**: Prepared contributions and the Special Report will be presented and discussed
Friday	2024-09-13			Deadline for submission of written spontaneous contributions